

## The Public Archives at the NASA Michelson Science Center

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**Abstract.** This presentation describes the scientific data sets and user services accessible through the public archive at the Michelson Science Center (MSC). The MSC is charged by NASA with providing long-term data archiving capabilities for the Navigator Program, whose goal is to detect and characterize Earth like planets around stars other than the Sun. The archive makes extensive re-use of the component-based software architecture of the NASA IPAC Infrared Science Archive (IRSA). It also re-uses IRSAs Configuration Management system, user support tools, and development and data ingestion processes.

### 1. Introduction

The NASA Navigator Program conducts advanced telescope searches for extra-solar planets and habitable environments. The Michelson Science Center (MSC) is the Navigator Programs Science Center. The MSC provides long-term data archiving capability for data that is in direct support of extra-solar planet activities, including extra-solar planet hunting and planet characteristics; radial velocity (spectroscopy); astrometry (interferometry); transits (high precision photometry); direct detection (high contrast detection); characteristics of exoplanet host stars; and validated data sets of stellar characteristics for known and potential exoplanet bearing stars.

The MSC currently serves the following data sets:

- Level-1 data from the Palomar Test-bed Interferometer (PTI), a pairwise combination of three 0.4-m siderostats.
- Level-1 data from the Keck Interferometer (KI), an interferometric combination of the two 10-m Keck telescopes on an 85 m baseline.
- Level-0 data from the CCD mosaic upgrade to the High Resolution Echelle Spectrograph (HIRES), at the W. M. Keck Observatory (The Keck Observatory Archive).
- The Stellar Archive and Retrieval System (StARS) database, which augments the *Hipparchos* catalog with stellar parameters from the literature, intended to identify candidate stars for planet finding missions (Stellar Archive and Retrieval System)
- Transit stars: Stellar Variability and Transit Searching datasets: Several scientists at the MSC are involved in ground-based surveys to search for transiting extra-solar planets. The data from these surveys, which are archived and served to the public by the MSC, provide information about the intrinsic variability of stars and the frequency of transiting extra-solar planets.

Table 1 summarizes the data sets that are scheduled for ingestion into the MSC archives; the table includes a summary of the content of the data sets and their scientific applicability.

Table 1. Planet Finding Datasets at the MSC

<b>Data Set</b>	<b>Archive Status</b>	<b>Data Type</b>
Keck Interferometer <sup>a</sup>	Public	Interferometry
Palomar Test-bed Interferometer <sup>b</sup>	Public	Interferometry
Large Binocular Telescope Interferometer <sup>c</sup>	Development	Interferometry
Space Interferometry Mission <sup>d</sup>	Launch 2012 est	Interferometry
Keck Observatory Archive <sup>e</sup>	Public	Spectroscopy
Stellar Archive and Retrieval System <sup>f</sup>	Beta release	Compiled Data Set
Transit and Variable Star Archive <sup>g</sup>	Advanced Prototype	Photometry

<sup>a</sup>Exo-zodiacal dust, direct detection of brown dwarfs and Jupiter-mass planets

<sup>b</sup>Astrometry, orbits, stellar astrophysics

<sup>c</sup>Ex-zodiacal dust, direct detection of brown dwarfs and Jupiter-mass planets

<sup>d</sup>Exo-planet astrometric searches, stellar astrophysics

<sup>e</sup>Exo-planet radial velocity searches, stellar astrophysics

<sup>f</sup>Compiled data on solar-like stars to support target selection for planet-finding missions

<sup>g</sup>Exo-planet transit searches, stellar astrophysics

The rest of this paper summarizes the archives or data sets that have been released to the public, or are scheduled for release this year. They are the W. M. Keck Observatory Archive, the Keck Interferometer (KI) and Palomar Test-bed Interferometer (PTI) archives, the Stellar Archive and Retrieval System (StARS) and Transit Search and Variability Archive (TranSVar). The MSC archive re-uses the component-based software architecture of IRSA, which is based at the Infrared Processing and Analysis Center. Berriman et al. (2006) describe in more detail the architecture and its extension to the MSC.

## 2. W. M. Keck Observatory Archive

The KOA<sup>1</sup> is a collaboration between the MSC and the W. M. Keck Observatory. It is ingesting level 0 (unprocessed) data from the CCD upgrade to the High Resolution Echelle Spectrograph. The upgrade installed three new CCD chips that greatly improved the sensitivity of the spectrograph in the blue spectral region, while preserving the wavelength coverage into the red. Science and calibration data, quick-look JPEG images of each CCD, weather information, and telescope logs are ingested into the archive within 30 days of the observations. As of 2006 September, there are 1.08 TB of data in the archive, inclusive of over 59,000 science and calibration files, quick-look images, and ancillary information.

Principal Investigators have proprietary access to their data for at least 18 months from the date of observation; extensions may be granted per CCD. The

<sup>1</sup><http://msc.caltech.edu/archives/koa/>

KOA was released to the public on 2006 July 17. New data are made public each day as proprietary periods expire. Calibration files, program metadata, and quick-look images are released as the science files are released. As of 2006 September a total of 9,170 science frames had been released. The archive has received over 3,500 queries, and over 100 GB of data have been downloaded from it.

The KOA user interface offers searches by position and target name, instrument parameters and program information, and supports searches for weather information for each night. The return page includes metadata, as well as links to the science files and the quick-look images. Files may be downloaded one-by-one or bundled on the fly. Should any of three CCDs in a program remain protected, the data are set to zero values in the files returned to the user, and the quick-look images for the protected frames are not returned. Future plans include serving level 1 (calibrated) observations.

### 3. Keck Interferometer and Palomar Test-bed Interferometer

The KI and PTI Archives serve level-0 and level-1 observations from KI, and level-1 observations from PTI. The data become public following expiration of the proprietary period. The PTI archive publicly serves 700 sources with 300,000 data points in over 950 nights. The KI archive holds 2 TB of data from 50 science sources and calibrators. The two archives offer two user interfaces: searches on individual targets or projects for the KI<sup>2</sup> and the PTI<sup>3</sup>; and spatial searches, inventories and sky coverage statistics at the IRSA<sup>4</sup>. Future plans for PTI include level-2 products (fully calibrated visibilities), and for KI include nulling-mode support, and phase referencing and astrometry mode.

### 4. Stellar Archive and Retrieval System

StARS archives and serves relevant data for the planet finding and astrobiology communities. It provides traceability of all data to their sources, and delivers tools to derive astrophysical parameters from archived data. As of 2006 October StARS<sup>5</sup> is in beta-release, with a full deployment expected in early 2007. The beta-release supports access to the Hipparcos catalog, which has been extended with information from the following sources:

- IRAS Point-Source Catalogs ( $\approx 100,000$  stars)
- Spectral types from the HD catalog ( $\approx 100,000$  stars)
- New radial velocities, rotational velocities, and iron abundances (Fe/H) ( $\approx 2000$  stars)
- Data on known extra-solar planets from radial-velocity surveys ( $\approx 200$  stars)

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<sup>2</sup><https://mscweb.ipac.caltech.edu/mscdat-ki/secure/main.jsp>

<sup>3</sup><https://mscweb.ipac.caltech.edu/mscdat-pti/secure/main.jsp>

<sup>4</sup><http://irsa.ipac.caltech.edu/data/MSCP.TI.KI/>

<sup>5</sup><http://stars.ipac.caltech.edu>

Future releases will support other data sets that are relevant to planet finding, including HIRES spectra from the N2K program and intermediate-resolution spectra from the NSTAR program.

## 5. Transit Search and Variability Archive

The first data set in the TranSVar archive consists of observations of the open cluster NGC2301. A total of 14 nights of observations yielded 4000 differential light curves in  $B$  and  $R$ . The data were generously donated by Drs. J. Tonry and S. Howell (see Tonry et al. 2005; Howell et al. 2005). The dataset can be considered a path-finder for developing user services for transit and variability data sets.

A user interface for querying the data is an advanced prototype, with release scheduled for early 2007. Future plans include more data sets and tools for visualizing and processing light curves.

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